

We Claim As Our Invention:

1. A camera calibration device for calibrating a stereo system, which includes a base camera and a detection camera, the device comprising:

- an image holding device for holding images obtained by shooting a plane,
5 where a known pattern is drawn, with the base camera and the detection camera at
at least three view points free from any spatial positional restriction; and
a parameter calculating device for calculating parameters necessary for
distance measurement in the stereo system based on the images held by the image
holding part.

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2. A camera calibration device as claimed in claim 1, wherein the parameter calculating device comprises:

- a first part for presuming distortion parameters of the base camera and the
detection camera by the use of the shot images;
15 a second part for calculating projective transformation matrixes to project
the shot images respectively onto predetermined virtual planes;
a third part for calculating internal parameters of the base camera on the
basis of the projective transformation matrixes obtained by the second part with
regard to the images from the base camera;
20 a fourth part for presuming the position of the shot plane based on both the
internal parameters of the base camera calculated by the third part and the images
obtained from the base camera; and
a fifth part for calculating projection matrixes for the detection camera
based on both parameters of the plane position presumed by the fourth part and the
25 images obtained from the detection camera.

3. A camera calibration device as claimed in claim 1, further comprising:

- a parameter correcting device for optimizing the plane position parameters
30 and the projection matrixes for the detection camera based on more than two

images obtained from the base camera and the detection camera and held by the image holding device.

4. A camera calibration device as claimed in claim 3, wherein the
5 parameter correcting device comprises:
a sixth part for calculating projective transformation matrixes to project the
images respectively onto predetermined virtual planes;
a seventh part for presuming the position of the shot plane based on both the
internal parameters of the base camera and the images obtained from the base
10 camera;
an eighth part for calculating projection matrixes for the detection camera
based on both parameters of the plane position presumed by the seventh part and
the images obtained from the detection camera; and
a ninth part for optimizing the plane position parameters and the projection
15 matrixes for the detection camera based on the shot images.

5. A camera calibration device as claimed in claim 1, wherein at least
one of the distortion parameters and the projective transformation matrixes are
calculated through a process of image registration which registers the individual
20 images in a manner to form a predetermined synthetic image.

6. A camera calibration method for calibrating a stereo system, which
includes a base camera and a detection camera, by using images obtained by
shooting a plane, where a known pattern is drawn, with the individual cameras at
25 least three view points free from any spatial positional restriction, the method
comprising the steps of:
presuming distortion parameters of the base camera and the detection
camera by using the images thus obtained;
calculating projective transformation matrixes to project the images
30 respectively onto predetermined virtual planes;

calculating internal parameters of the base camera based on the projective transformation matrixes obtained during the step of calculating projective transformation matrixes with regard to the images from the base camera;

- presuming the position of the shot plane based on both the internal
5 parameters of the base camera calculated at the step of calculating internal parameters and the images obtained from the base camera; and

calculating projection matrixes for the detection camera based on both parameters of the plane position presumed at the step of presuming and the images obtained from the detection camera.

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7. A camera calibration method as claimed in claim 6, further comprising the step of:

optimizing the plane position parameters and the projection matrixes for the detection camera based on more than two images obtained from the base camera
15 and the detection camera.

8. A camera calibration method as claimed in claim 7, wherein the step of optimizing the plane position parameters comprises the steps of:

- calculating further projective transformation matrixes to project the images
20 respectively onto predetermined virtual planes;

presuming further the position of the shot plane based on both the internal parameters of the base camera and the images obtained from the base camera;

- calculating further projection matrixes for the detection camera based on
both parameters of the plane position presumed during the step of presuming and
25 the images obtained from the detection camera; and

optimizing further the plane position parameters and the projection matrixes for the detection camera based on the shot images.

9. A camera calibration method as claimed in claim 6, wherein at least
30 one of the distortion parameters and the projective transformation matrixes are

calculated through a process of image registration which registers the individual images in a manner to form a predetermined synthetic image.

10. A computer system for running a processing routine of camera calibration for a stereo system, which includes a base camera and a detection camera, by using images obtained by shooting a plane, where a known pattern is drawn, with the individual cameras at at least three view points free from any spatial positional restriction, the computer system comprising:
- a storage medium for storing computer software in a format readable by the computer system; and
 - computer software for executing, on the computer system, the processing routine of camera calibration, the computer software including a first program step of presuming distortion parameters of the base camera and the detection camera by using the images thus obtained, a second program step of calculating projective transformation matrixes to project the images respectively onto predetermined virtual planes, a third program step of calculating internal parameters of the base camera based on the projective transformation matrixes obtained at the second program step with regard to the images from the base camera, a fourth program step of presuming the position of the shot plane based on the internal parameters of the base camera calculated at the third program step, and also based on the images obtained from said base camera, and a fifth program step of calculating projection matrixes for the detection camera based on both parameters of the plane position presumed at the fourth program step, and the images obtained from the detection camera.
11. A computer system as claimed in claim 10, wherein the computer software further includes a parameter correcting program step of optimizing the plane position parameters and the projection matrixes for the detection camera based on more than two images obtained from the base camera and the detection camera.

12. A computer system as claimed in claim 11, wherein the parameter
correcting program step includes a sixth program step of calculating projective
transformation matrixes to project the images respectively onto predetermined
virtual planes, a seventh program step of presuming the position of the shot plane
5 based on the internal parameters of the base camera and the images obtained from
the base camera, an eighth program step of calculating projection matrixes for the
detection camera based on both parameters of the plane position presumed at the
seventh program step, and the images obtained from the detection camera, and a
ninth program step of optimizing the plane position parameters and the projection
10 matrixes for the detection camera based on the shot images.

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